MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

TAI2151 – ARTIFICIAL INTELLIGENCE FUNDAMENTALS

(All Sections/Groups)

18 October 2016
9.00am – 11.00am
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of **6** pages with **5** questions only.
2. Attempt **ALL FIVE** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the answer booklet provided.

Question 1

Imagine a futuristic world where numerous types of robots are used. One is an armoured transport vehicle whose job is to take a person to a location of that person's choice. The transport only drives to approved locations and only on special roads dedicated to transport robots. The speed limit is the same for all roads. Traffic is not an issue as all roads are single lane in each direction and all traffic moves at the same speed. There are no issues related to sensing. The robot software is implemented using a goal-based architecture. The following is the PEAS description:

Performance: Get person to location, take shortest route
Environment: Client, enemies, other vehicles, roads
Actuators: Steering, accelerator, brake, speaker
Sensors: Camera, sonar, speedometer, GPS, voice input

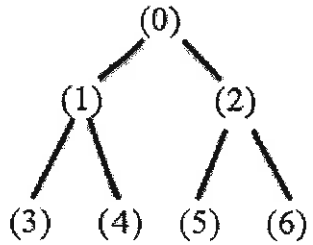
(a) Describe the environment with some justifications:
Is it fully or partially observable? (1 mark)
Is it deterministic or stochastic? (1 mark)
Is it static or dynamic? (1 mark)
Is it discrete or continuous? (1 mark)
Is it single or multi-agent? If multi-agent, who are the other agents and are the agent interactions competitive or cooperative? (2 marks)

(b) What in this problem makes a goal-based architecture a good choice? (2 marks)
Why aren't the simple or model-based reflex architectures a good choice? (2 marks)

Continued....

Question 2

Given the following state tree:

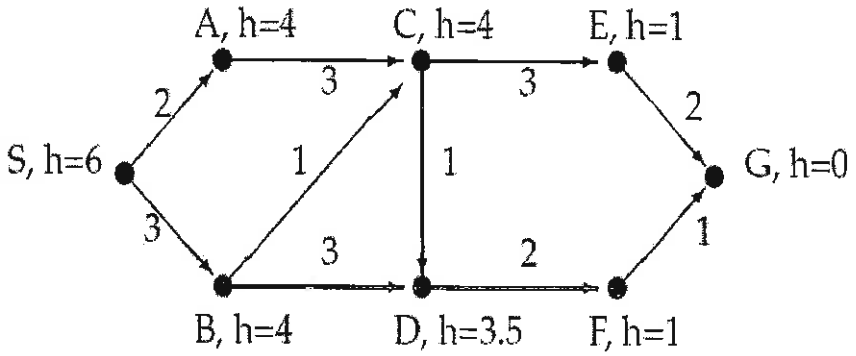


State (0) expands to (1) & (2), state (1) to (3) & (4), and state (2) to (5) & (6). And the Breadth First Search (BFS) and Depth First Search (DFS) implementation are such that the fringe would look like {(1), (2)} after expanding (0). *Note the fringe is an ordered list*

If a search problem starts at state (0), after expanding the first (and only) search node, the fringe looks like {(1), (2)}, implying that (1) will be the next search state expanded.

(i) For BFS, what would the fringe look like after expanding state (1)? (1 mark)
(ii) For DFS, what would the fringe look like after expanding state (1)? (1 mark)

(b) The graph below represents a problem space. Nodes are labelled with a letter and the value of a heuristic function ***h*** for the node. Edges are labelled with the cost of traversing the edge. Suppose we want to use the A* algorithm on the graph to find the path from node ***S*** to node ***G***.



(i) Simulate running the A* algorithm on the graph by filling in lines in the table below, showing the ***f***, ***g***, and ***h*** values of each node on the queue. We have done the first two lines as an example. If you find a new path to a node already on the queue, update its cost (using the lower ***f*** value) instead of adding another copy of that node to the queue. Keep the queue sorted. (6 marks)

Continued....

Iteration	Node Visited / Expanded	Priority Queue (aka Fringe, Open List) Notation for a Node is NAME(F value, G value, H value)
0	--	S(6,0,6)
1	S	A(6,2,4), B(7,3,4)
2		
3		
4		
5		
6		
7		
8		
9		
10		

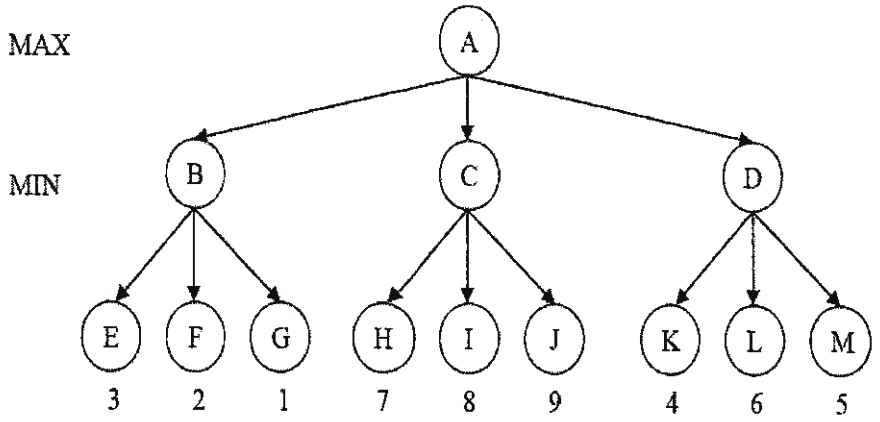
(ii) For the solution found by A*, give the cost and sequence of nodes comprising the path.

(2 marks)

Continued....

Question 3

Consider this game tree where the root is a maximizing node, and children are visited left to right.



(a) Compute the minimax game value of nodes A, B, C, and D using the standard minimax algorithm. (2 marks)

(b) What move will be selected by player one using minimax? (1 mark)

(c) List the nodes (leaves or interior nodes) that alpha-beta algorithm prunes (i.e., decides need not be examined). (2 marks)

(d) The number of nodes that alpha-beta algorithm prunes depends on how each node's children are ordered in the tree. How to obtain a new game tree by re-ordering the children of each internal node, such that the new game tree is equivalent to the tree above, but alpha-beta pruning will prune as many nodes as possible? List the nodes that would be pruned.

(5 marks)

Continued....

Question 4

You are given the following predicates:

dog(X) = X is a dog
animal(X) = X is an animal
dies(X) = X dies

(a) Translate the following English sentences into First-Order Logic statements:
1. Fido is a dog.
2. All dogs are animals.
3. All animals will die. (2 marks)

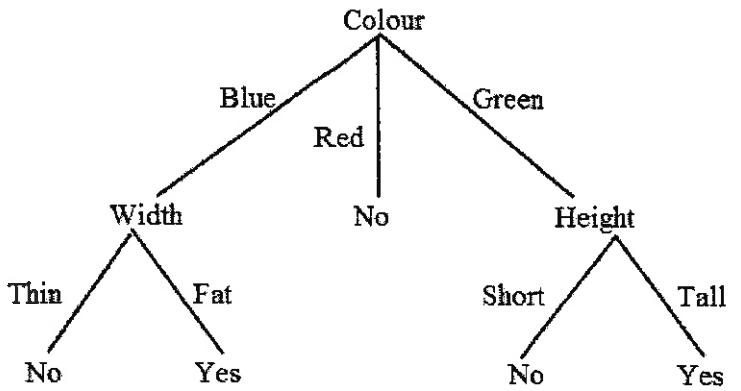
(b) Convert the First-Order Logic statements obtained in (a) into Conjunctive Normal Form. (2 marks)

(c) Use resolution refutation to prove that Fido will die. (6 marks)

Continued....

Question 5

(a) Given the following decision tree, show how the new examples in the table would be classified by filling in the last column in the table. If an example cannot be classified, enter UNKNOWN in the last column.



Example	Colour	Height	Width	Class
A	Red	Short	Thin	
B	Blue	Tall	Fat	
C	Green	Short	Fat	
D	Green	Tall	Thin	
E	Blue	Short	Thin	

(2 marks)

(b) We would like to predict the sex of a person based on two binary attributes: ***leg-cover*** (***pants*** or ***skirts***) and ***facial-hair*** (***some*** or ***none***). We have a data set of 2,000 individuals, half male and half female. 75% of the males have no facial hair. Skirts are worn by 50% of the females. All females are barefaced and no male wears a skirt.

For your information, $\log_2(1/8) = -3.00$, $\log_2(1/4) = -2.00$, $\log_2(1/3) = -1.58$, $\log_2(3/8) = -1.42$, $\log_2(3/7) = -1.22$, $\log_2(1/2) = -1.00$, $\log_2(4/7) = -0.81$, $\log_2(5/8) = -0.68$, $\log_2(2/3) = -0.58$, $\log_2(3/4) = -0.42$, $\log_2(7/8) = -0.19$

(i) What is the initial entropy in the system? (2 marks)

(ii) Compute the information gain of initially choosing the attribute ***leg-cover*** and for initially choosing ***facial-hair***. (4 marks)

(iii) Based on yours answers, which attribute should be used as the root of a decision tree?

(2 marks)

End of Paper